Residential Air Handling Units for better indoor air quality and energy efficiency

Eurovent Certita Certification launched in 2014 a new certification programme for residential air handling units in line with existing European standards and regulations focusing on energy efficiency.

In 2017 a new performance index will be introduced for these products allowing to evaluate the efficiency towards Indoor Air Quality.

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Background

Back in 2014 Eurovent Certita Certification started a new certification programme for Residential Air Handling Units. This programme is based on state-of-art European testing standard EN 13141-7 and in-line with the European regulations 1253/2014 and 1254/2014 related respectively to Ecodesign and Energy Labelling.

This certification programme concerns only balanced supply and exhaust ventilation units including a heat recovery systems (plate, rotary or heat-pumps). These systems are becoming more and more popular in Europe and not only in Scandinavia due to the stricter requirements regarding energy efficiency in residential buildings. Dwellings are becoming more and more isolated and tight in order to save energy for heating. Infiltration through the building envelope are therefore minimized and mechanical ventilation is therefore necessary to renew the air inside houses.

A good ventilation system should gather the following characteristics:

- insure the renewal of the air according to the needs related to indoor sources of pollutants (occupancy and building materials)
- consume a small amount of energy directly (through the consumption of the fans) or indirectly by discharging warm air from inside to outside while providing cold air from outside to inside
- produce a sufficiently low sound power level so that occupants do not switch off the unit due to noise pollution
- be airtight in order to not recirculate indoor pollutants back in the building
- provide clean air inside even when outdoor air is polluted

A European wide certification programme for Residential Air handling Units

The scope of the Eurovent certification programme includes all balanced supply and exhaust ventilation units with heat recovery systems (plate, rotary or heat-pump) up to 1 000 m^3/h nominal airflow.

The following characteristics are certified:

- Leakage class
- Aeraulic performances (Airflow/pressure curves, Maximum airflow [m^3/h])
- Electrical consumption [W]
- Specific Power Input SPI [$W/(m^3/h)$]
- Temperature efficiency / COP
- Performances at cold climate conditions
- SEC (Specific Energy Consumption) [$kWh/(m^2.year)$]
- A-weighted global sound power levels [dB(A)]

All performances are checked by tests done according to the European standard EN 13141-7:2011 by independent testing laboratories accredited according to ISO 17025.

Aeraulic performances are verified for a certified window as described in **Figure 1**.

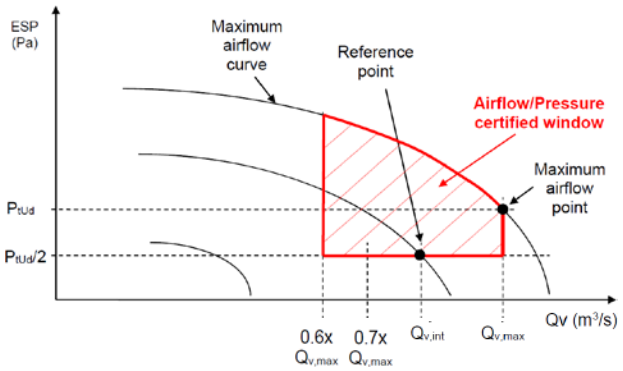

Figure 1. Certified window of airflow/pressure curves according to RS 15/C/001-2015.

Leakage classes are defined based on both internal and external leakages (see **Table 1** for an example).

Heat recovery systems are evaluated according to the conditions given in **Table 2**.

Table 1. Leakage classification for the pressure method according to EN 13141-7:2011.

Class	Pressurization test		
	Internal leakage (at 100 pa)		External leakage (at 250 pa)
A1	≤2%	and	≤2%
A2	≤5%	and	≤5%
A3	≤10%	and	≤10%
Not classified	>10%	and	>10%

This certification programme is based on random selection of units purchased directly on the market thus allowing to assess the real performances of the units provided to end users.

Energy efficient ventilation

Even if this certification programme was introduced in the course of 2014, it already included at this time the characteristics of the European regulations 1253/2014 and 1254/14 which were applied on the European market on the 1st of January 2016. These regulation introduced Ecodesign regulations for residential ventilation systems as well as requirements regarding the way performances shall be displayed, in particular regarding energy efficiency with a dedicated energy efficiency label.

This energy efficiency classification is based on the Specific Energy Consumption (SEC) which accounts for both the direct energy consumption of the fans but also the indirect energy consumption related to the heat recovery efficiency.

The Eurovent certification programme is therefore a good mean to verify the compliance of ventilation units according to these regulations.

Ventilation for a better Indoor Air Quality

Even though energy efficiency is a key element when looking at residential ventilation units, the first performance parameter for such unit is its ability to maintain a good indoor air quality in the building.

As seen before this is related to the ability of the unit to:

- remove indoor pollutants from occupant activities (CO_2, humidity) and from building materials (COVs)
- prevent outdoor pollutants to enter into the building (particulate matter)
- not re-introduce indoor pollutants in the building

Table 2. Testing conditions for heat-recovery efficiency according to EN 13141-7.

Application Mode	Standard test			Cold Climate test
Point number:	1	2	3	4
Heat Exchanger category	I and II (mandatory)	I (mandatory) and II (optional)	I and II (optional)	I and II (optional)
Extract air				
Temperature	20°C	20°C	20°C	20°C
Wet bulb	12°C	15°C	12°C	10°C
Supply air				
Temperature	7°C	2°C	-7°C	-15°C
Wet bulb	-	1°C	-8°C	-

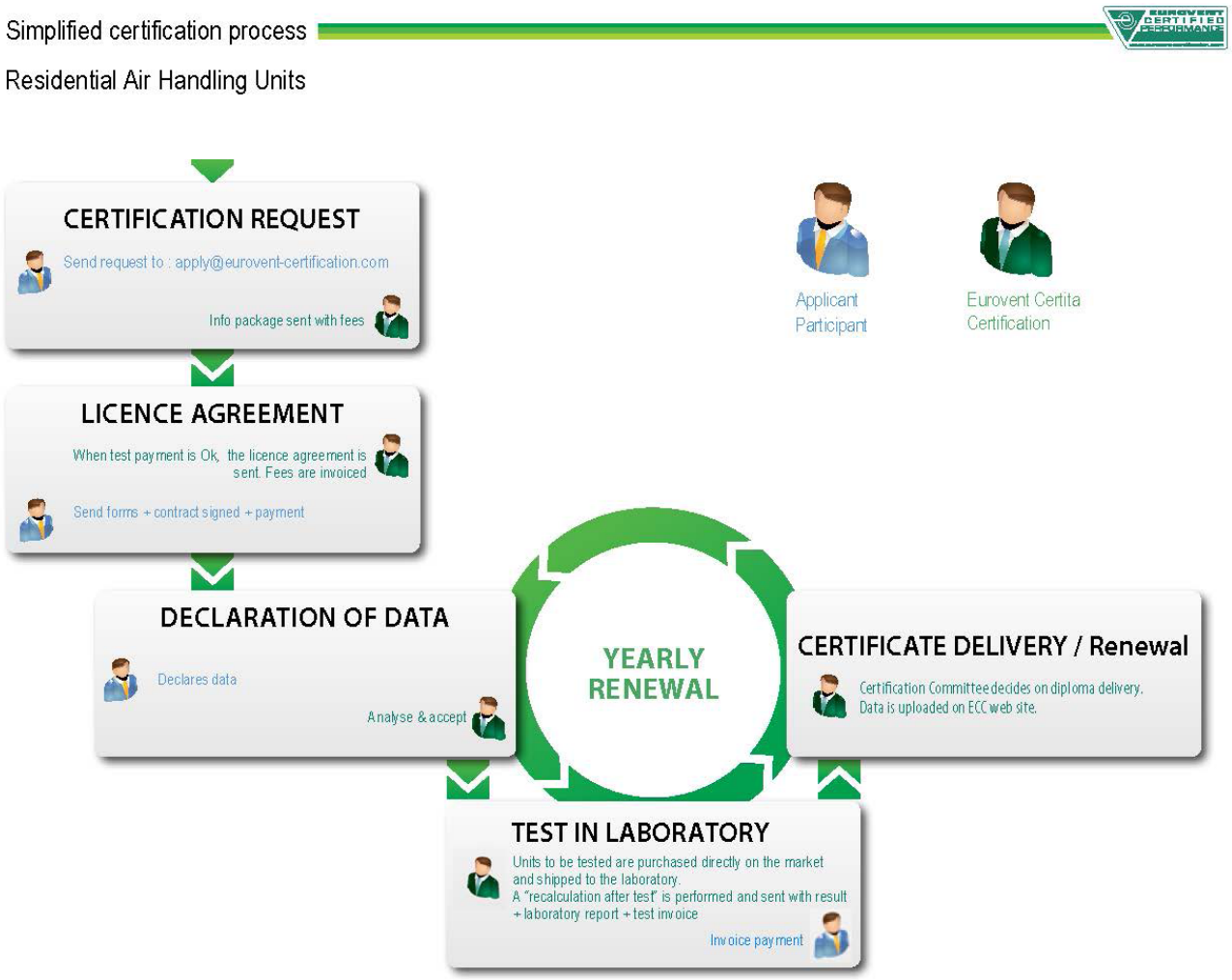

Figure 2. Simplified certification process for the RAHU Eurovent programme.

All of these should be done at the lowest cost possible.

In order to characterize this essential characteristic of these products ECC decided to introduce a new metric allowing to take into account all these parameters: the Clean Air Efficiency (CAE):

$$CAE = \frac{Amount\ of\ clean\ air\ delivered\ to\ the\ building}{Total\ energy\ used} \quad \left[\frac{m^3/h}{MWh/year}\right] \qquad \textbf{(Eq. 1)}$$

In order to define what "clean air" is, only the main pollutants are taken into account:

- Indoor pollutants:
- CO_2
- Humidity
- Outdoor pollutants:
- Particulate matter

Other pollutants can also be found such as COVs coming from building materials indoors (formaldehyde) or from outdoors (benzene), allergens from indoors (pets) or outdoors (pollen), micro-organisms etc. It was deliberately decided to focus on the main pollutants in order to achieve a good balance between relevance and simplicity.

As a result the amount of clean air delivered to the building is assumed to be the minimum between the clean air delivered related to indoor pollutants (CO_2 and humidity) and the clean air delivered related to outdoor pollutants:

$$Amount\ of\ clean\ air\ delivered\ to\ the\ building = Min\left(q_{clean\ air\ CO_2,H_2O}, q_{clean\ air\ ePM1}\right) \qquad \textbf{(Eq. 2)}$$

The amount of clean air concerning CO_2 and humidity is simply the amount of air removed from the building

by ventilation minus the amount of air recirculating from the extract air side to the supply air side due to internal leakages within the ventilation unit:

$$q_{clean\ air\ CO_2,H_2O} = (1 - EATR) \cdot q_{v,int} [m^3/h] \quad \textbf{(Eq. 3)}$$

With:

EATR: the Exhaust Air Transfer Ratio [–] which accounts for internal leakages from the extract side to the supply side

$q_{v,int}$: the airflow rate at the referent point according to EN 13141-7 [m^3/h]

The amount of clean air concerning particulate matter is considered to be related to the efficiency of the air filters towards PM_1 particles. PM_1 particles are the most harmful category of particles which are from various origins (dust, combustion particles, bacteria, viruses). These particles are able to enter into the deepest part of our lungs until the alveoli. Both supply and exhaust air filtration efficiencies have to be considered as indoor particulate matters may be re-introduced indoors through internal leakages (**Eq.4**).

In order to define the total energy used by the unit we propose to introduce the Total Energy Consumption TEC in kWh/m²/year which is analogous to the SEC but which is always positive (**Eq.5–7**).

$$q_{clean\ air\ ePM1} = \left(ePM_{1,supply} \cdot (1 - EATR) + ePM_{1,exhaust} \cdot EATR\right) \cdot q_{v,int} [\mathrm{m^3/h}] \quad \textbf{(Eq. 4)}$$

$ePM_{1,supply}$ and $ePM_{1,exhaust}$: efficiencies against PM_1 particles of the supply air and exhaust air filters respectively.

$$TEC_{RAHU} = t_a \cdot pef \cdot q_{net} \cdot MISC \cdot CTRL^x \cdot SPI_{RAHU} + t_h \cdot \Delta T_h \cdot \eta_h^{-1} \cdot c_{air} \cdot q_{net} \cdot CTRL \cdot MISC \cdot (1 - \eta_t) + Q_{defr} \quad \textbf{(Eq. 5)}$$

$$TEC_{RAHU} = SEC_{RAHU} + K \ [\mathrm{kWh/m^2/year}] \quad \textbf{(Eq. 6)}$$

With:

$K = t_h \cdot \Delta T_h \cdot \eta_h^{-1} \cdot c_{air} \cdot q_{ref}$: constant value [kWh/m²/year]

Finally:

$$CAE = \frac{Min(q_{clean\ air\ ePM1}; q_{clean\ air\ CO_2,H_2O})}{TEC_{RAHU} \cdot \frac{q_{v,int}}{q_{net}}} \left[\frac{\mathrm{m^3/h}}{\mathrm{kWh/year}}\right] \quad \textbf{(Eq. 7)}$$

With:

q_{net}: net ventilation rate demand per m^2 heated floor area [m^3/h.m^2]

Table 3. Typical CAE values.

	Poor	Average	Good
Supply air filter	G3	M5	F7
Exhaust air filter	G3	M5	F7
Leakage class (EATR)	A3 (10%)	A2 (5%)	A1 (2%)
SPI [W/(m³/h]	0.50	0.35	0.25
HRS efficiency	55%	80%	90%
Ventilation control (CTRL)	Clock control (CTRL=0.95)	Central demand control (CTRL=0.85)	Local demand control (CTRL=0.65)
Motor drive (x)	2-speed (x=1.2)	Multi-speed (x=1.5)	Variable speed (x=2=
CAE [(m³/h)/(MWh/year)]	**5**	**20**	**146**

In order to have basic figures in mind, the **Table 3** summarizes typical CAE values for poor, average and good ventilation units.

Conclusion

Recent European regulations have already shaped the market towards better energy efficient products. However, it has to be kept in mind that the primary role of ventilation units is to bring clean air to building occupants. In order to highlight this a new, simple and meaningful metric was developed within the Eurovent Certification programme for Residential Air Handling Units: the Clean Air Efficiency (CAE). This performance will be made available for all Eurovent certified units by the 1st of March 2017. It will allow end-users to compare easily products between each other's regarding their essential characteristic that is its ability to provide good indoor air quality in buildings. ■

Reference documents

OM-16, Operational Manual for the Certification of Residential Air Handling Units, November 2015, wwww.eurovent-certification.com

RS 15/C/001-2015, Rating Standard for the Certification of Residential Air Handling Units, November 2015, wwww.eurovent-certification.com

EN 13141-7 :2011, Performance testing of components/products for residential ventilation. Part 7: Performance testing of a mechanical supply and exhaust ventilation units (including heat recovery) for mechanical ventilation systems intended for single family dwellings.

COMMISSION REGULATION (EU) No 1253/2014 of 7 July 2014 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for ventilation units, http://eur-lex.europa.eu

COMMISSION DELEGATED REGULATION (EU) No 1254/2014 of 11 July 2014 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of residential ventilation units, http://eur-lex.europa.eu